

3-20-2021

Parallel Philosophy: Origin and Goal of Intelligent Industries and Smart Economics

Fei-Yue WANG

Institute of Automation, Chinese Academy of Sciences, Beijing 100190, China, feiyue.wang@ia.ac.cn

Recommended Citation

WANG, Fei-Yue (2021) "Parallel Philosophy: Origin and Goal of Intelligent Industries and Smart Economics," *Bulletin of Chinese Academy of Sciences (Chinese Version)*: Vol. 36 Article 9.

DOI: <https://doi.org/10.16418/j.issn.1000-3045.20210301001>

Available at: <https://bulletinofcas.researchcommons.org/journal/vol36/iss3/9>

This Philosophy and Science is brought to you for free and open access by Bulletin of Chinese Academy of Sciences (Chinese Version). It has been accepted for inclusion in Bulletin of Chinese Academy of Sciences (Chinese Version) by an authorized editor of Bulletin of Chinese Academy of Sciences (Chinese Version). For more information, please contact lcyang@cashq.ac.cn, yjwen@cashq.ac.cn.

Parallel Philosophy: Origin and Goal of Intelligent Industries and Smart Economics

Abstract

What are the nature and goal of Intelligent Technology? What are the origin and mission of Intelligent Science? What are the impact and significance of Intelligent Industries to our societies and the future development of Human Being? Starting from the topic of AlphaGo, based on Karl Popper's Three Worlds theory, this article addresses the above questions and discussed the beginning and trend of Artificial Intelligence and Parallel Intelligence. It then proposes Parallel Philosophy as the new philosophy system for Intelligent Science and Intelligent Technology, which extends the scope of traditional philosophy from Being, Becoming to Believing, and the corresponding Knowledge system from Descriptive, Predictive, to Prescriptive Knowledge. Intelligent Education and Smart Economics are used as two most important examples in the study here.

Keywords

Artificial Intelligence, Parallel Intelligence, Parallel Philosophy, Intelligent Industries, Intelligent Economics, Parallel Economics, Intelligent Education, Parallel Education

Citation: WANG Fei-Yue. Parallel Philosophy: Origin and Goal of Intelligent Industries and Smart Economics [J]. Bulletin of Chinese Academy of Sciences, 2021 (3): 308–318.

Parallel Philosophy: Origin and Goal of Intelligent Industries and Smart Economics*

WANG Fei-Yue

Institute of Automation, Chinese Academy of Sciences, Beijing 100190, China

Abstract: What are the nature and goal of intelligent technology? What are the origin and mission of intelligent science? What are the impact and significance of intelligent industries to our societies and the future development of human being? Starting from the topic of AlphaGo, based on Karl Popper's three worlds theory, this article addressed the above questions and discussed the beginning and trend of artificial intelligence and parallel intelligence. It then proposes parallel philosophy as the new philosophy system for intelligent science and intelligent technology, which extends the scope of traditional philosophy from "being," "becoming" to "believing," and the corresponding knowledge system from descriptive, predictive, to prescriptive knowledge. Intelligent education and smart economics are used as two most important examples in the study here. DOI: 10.16418/j.issn.1000-3045.20210301001-en

Keywords: artificial intelligence; parallel intelligence; parallel philosophy; intelligent industry; intelligent economics; parallel economics; intelligent education; parallel education

Compared with the traditional industrial technology and modern information technology, what does the future intelligent technology mean? What are the nature, origin, and goal of intelligent technology? What are its impacts on the development of human society? More than 80 years ago, inspired by "Hilbert's Programme" of mathematical axiomatization and mechanization, and *Principles of Mathematics* written by Russell and Whitehead, Church and his doctoral candidate Turing proposed "Lambda Operation" and "Turing Machine," respectively, which were equivalent mathematically, constituting the well-known "Church-Turing Thesis." The studies on computer, information industry and artificial intelligence (AI) were generated. In 2016, the emergence of AlphaGo Technology made people suddenly realize the power of AI. Significantly, it brought us a new thesis, namely "AlphaGo Thesis" [1]. As shown in Fig. 1, we have developed to the present day based on "Church-Turing Thesis," and we shall believe that "AlphaGo Thesis" will advance to tomorrow.

The core connotations of the so-called "AlphaGo Thesis" are ① parallel philosophy. Both virtuality and reality are not philosophical categories opposite to each other any more, instead, they are an integrated process parallelly interacting and entangling with each other. The philosophy should be extended to "believing" from "being" and "becoming." ② Paradigm shift. It shifts from Newtonian paradigm of "big law, small data" to Merton paradigm of "big data, small law." ③ Data intelligence. The data are the main raw material used to generate intelligence. Big data are generated from small

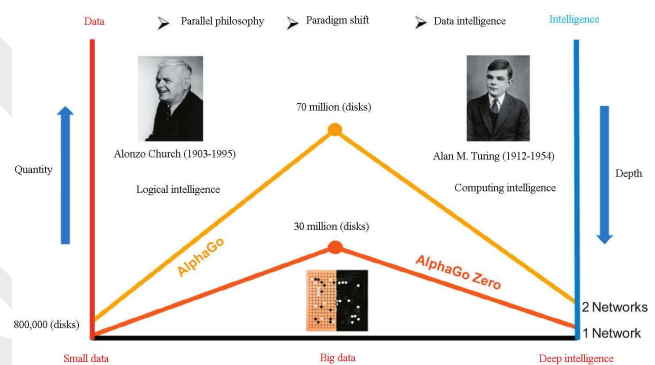


Fig. 1 From "Church-Turing Thesis" to "AlphaGo Thesis": toward intelligent industry and smart society

data, and precise knowledge or deep intelligence for specific scenarios or specific problems is extracted from the big data. That is to say, the process of "small data–big data–deep intelligence" will become the standard process of the intelligent industry.

In order to achieve healthy development and benefit maximization of AI and intelligent industry, the understanding about the intelligent science and technology must be first of all changed. Nevertheless, as what has been said by Smolin, a modern physicist, "That is philosophy when thoughts change your thoughts..., that is science when facts change your thoughts." The reason why we have selected "parallel" as the breakthrough to discuss and study parallel philosophy is that the breakthrough for the modern science

* Prepared based on the report made by WANG Fei-Yue at "Seminar on Frontier Issues in Science and Philosophy of Chinese Academy of Sciences" on September 24th, 2020.

Received: 2021-3-8

Supported by: The National Key Research and Development Plan (2018AAA0101502)

120 years ago was “parallel”! At that time, the size of the natural physical world for human to study became smaller and smaller, from molecule to atom and particle; then, it became bigger and bigger, from the earth to the entire universe; the speed became faster and faster, for which, the light speed must be considered. Especially, with black-body radiation and gravitational deflection, “the facts change the thoughts,” leading to the generation and development of new sciences of quantum mechanics and relativity. People have eventually realized in space, “parallel lines can intersect.” In this case, human went into the non-European space from the classical European space, and constructed a new science system of the modern physics, which made manufacturing of the semi-conductor computer come true and allowed us to have the present information technology and industry.

Nowadays, thanks to the rapid popularization of mobile internet and smart phone, the sizes of the social phenomena have become smaller and smaller, and nearly every person, matter, and emotion must be considered. At the same time, they have become bigger and bigger, from one country to the whole world, and the speed has become faster and faster. The speed of the online information is the light speed in nature, from “online tumor” to “online celebrity,” and new phenomena emerge continuously, triggering the call for new arts and new engineering sciences. People have clearly realized that, just like the shift from the classical physics to modern physics one hundred years ago, the social science must have a similar revolution to create “quantum mechanics” and “relativity” for social study and transform the science, engineering, humanities & social sciences. At this time, we must “change the thoughts with thoughts,” seek for philosophical breakthroughs and extend to “believing” from the cores of the classical philosophy “being” and “becoming,” thus shaping the new science philosophy about the intelligent technology in the new age. It is believed that the breakthrough is still “parallel.” To find the extension and sublimation of the intersection between the parallel lines in the physical world, one must make virtuality and reality to intersect in parallelism, and make the entanglement in the quantum mechanics turn into the technology and engineering of parallel philosophy, and make the internet of things (IoT), big data, cloud computing, robot, blockchain, machine learning, and AI become the describable, predictable, and guidable scientific means used to convert “Utopian social engineering” to “piecemeal social engineering.”

1 The third Axial Age and wisdom globalization

Since the appearance of Alpha Go, people have suddenly realized that the “old IT” representing information technology in the past has turned into the “new IT” representing intelligent technology in the new age. At the same time, as shown in Fig. 2, the persons of insight have realized that the

“aged IT” representing industrial technology, which changed the human society one hundred years ago, must be redefined. We must combine and develop the three parallel worlds that interweave and interact with each other recognized by Popper, a philosopher of science, and break through the Axial Age idea proposed by philosopher Jaspers, so as to make the three “aged, old, and new ITs” become the main tools for developing the physical world (world 1), mental world (world 2), and artificial world (world 3), thus entering into the third Axial Age [2,3].

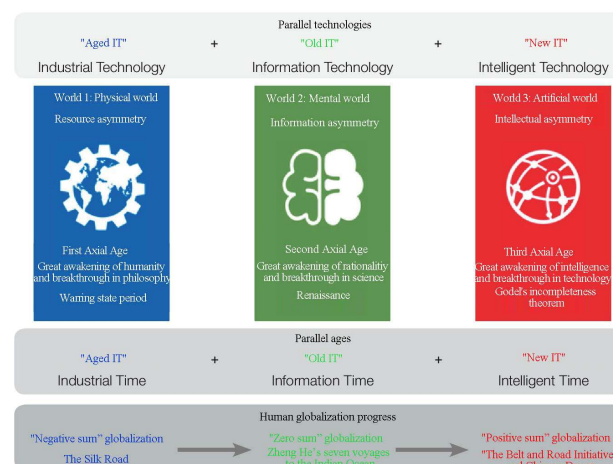


Fig. 2 Smart globalization with positive sum in the third Axial Age

Therefore, the parallelism among the three “ITs” has a profound philosophical foundation and support. The modern history of humankind is a history of exploiting the “three worlds” and improving humans and society. The “aged IT” exploited the physical world from the agriculture covering the surface resources to industry covering the underground resources, which to some extent eliminated the social difference in the humankind caused by ties of blood and asymmetrical resources. The “old IT” exploited the mental world from the telephone to television and mobile internet, and from the information-based society to the digital society, which is eliminating the social difference in the humankind caused by asymmetrical rationality and information. Nevertheless, asymmetry is the eternal power for the development of human society. New power is generated from new asymmetry, and the human society is advanced in this way. The emergence of AI just meets the need for developing the artificial world, makes the data become new “mineral reserves” and “energy” for the development of humankind, and makes the “new IT” become a new tool to develop the artificial world. The historic mission of AI is to reduce and even eliminate the social difference caused by asymmetry of intelligence and knowledge, thereby, allow humankind to develop better and more perfectly.

From 800 BC to 200 BC, a number of philosophers appeared independently in the “two rivers” of the Middle East, India, and China. They generated the overall self-awareness

of humankind, leading to great awakening of humanity and making breakthroughs in philosophy. In order to depict this grand chapter in the book of human history, Jaspers invented the expression of Axial Age^[4]. Obviously, the Axial Age proposed by Jaspers focuses on the physical world, but the mental world and artificial world also need to have their own Axial Age. It can be easily seen that the Axial Age of the mental world is just the great awakening of human rationality in the Renaissance. It spends about 600 years for Copernicus, Galileo, Newton, and Einstein on making scientific breakthroughs. Godel's incompleteness theorem proposed ninety years ago and the "principle of bounded rationality" proposed by Herbert Simon, one of the creators of AI and ever won the Nobel Economics Prize, are regarded as the beginning of Axial Age in the artificial world, which is the great awakening of human spirituality or intelligence. The Axial Age in the artificial world will certainly lead to breakthroughs in technology, and shape the development period led by intelligent science and technology. Centering on the corresponding axes from humanity, rationality, intelligence to philosophy, science, and technology, people are advancing to the beautiful goal step by step with increasingly clear means.

According to Marx Weber and Alfred Weber, humanity as well as the nature of human leads to the emergence of axial phenomenon in human society^[4]. Human has the instincts of fear, voracity, and idleness. Therefore, it is necessary for human beings to communicate, compare, seek consensus, specify standards, enhance efficiency, and "stay lazy" together. In this case, "axis" has been formed, and "globalization" movement has been shaped. ① In the physical world, the material occupation only had one situation, that is, "you have but I do not," thus resulting wars, invasions, oppressions, and colonizations. Therefore, globalization in world 1 was "negative sum" in nature. In the globalization movement of world 1, Chinese nation initially achieved "the same language on books, the same track for vehicles, and the same ethics for behaviors," and then "measured with the same metrics and lived in the same area." Finally, they unified characters, money, and metrology. China made the magnificent globalization feat of "the Silk Road" at the end of the first axis and promoted the construction of human civilization. ② In the mental world, since the Great Geographical Discovery, humankind has greatly extended the transaction activities between each other, which has led the "free trade" to become a new paradigm of development, therefore, making globalization of "zero sum" become possible. At the beginning of this wave of globalization, Chinese nation lagged far behind although there was the activity of "Zheng He's seven voyages to the Indian Ocean." The reform and opening-up for more than 40 years has finally shaped China into a prosperous country in the world. Nevertheless, the ideological trend of "America First" has caused a big danger to the "free trade" of "zero sum," so it is necessary to seek new thoughts for development.

The new thought lies in the new thinking mode, that is to

say, to abandon "stock thinking," embrace "increment thinking," develop world 3, and create a new globalization movement. Why? Because the artificial world is different from the other two worlds, nearly "creating things from nothing" based on knowledge. Everyone can share at the same time in the artificial world. This is another kind of "quantum parallel world," which ensures the third wave of globalization movement centered on the development of the artificial world. The globalization in the artificial world is "positive sum" and "multi-win containment" in nature. This is a globalization movement of wisdom, which has made "marginal utility" gradually become a new paradigm of the new intelligent economics. The artificial world is far bigger than the Pacific Ocean or even any physical region. It is believed that this globalization can not only provide respective development spaces for China and America (G2), but also provide sufficient development spaces for Group of Twenty (G20), or even provide all the necessary development spaces for all the countries in the world. On this occasion, it is hoped that "the Belt and Road Initiative" proposed by China become the trailbreaker of the new wave of wisdom globalization, and thus, the human community with a shared future will be constructed and Chinese Dream in the new age will be realized.

2 New infrastructure in the new age and the integration of new engineering sciences and arts

Since the beginning of the history, humankind has been carrying out "infrastructure construction" just like making a web by a spider. The "web" has been made from the first world to the third world, and the result is a "Grid Web" bigger than the "Network Web." The first big web "Grids 1.0" is the main network of the physical world, that is, the communication network, and the second big web "Grids 2.0" is the energy network, which has been made since more than 100 years ago, spanning over the "three worlds" since the beginning of the first world. The third big web "Grids 3.0" is the main network of the mental world, that is, the information network, which is represented by the internet, and the fourth big web "Grids 4.0" is IoT connected in the "three worlds" in series, of which, the core purpose is oriented at the world digitalization in world 3. The fifth big web "Grids 5.0" is the main network of the artificial world, that is, Internet of Minds (IoM)^[5]. In the internet, people are "passively connected." In the IoT, people are "pervasively connected." In the IoM, people are "prescriptively connected." Therefore, IoM must be constructed if people want to dominate the social development, and only in this way, intelligent economics can be shaped and the smart society can come into being. Currently, under the influence of "Big 5G" infrastructure construction, the social formation has undergone profound changes. New logistics starts to trigger the five emerging forms including

the social traffic, social energy, social computing, social manufacturing, and social intelligence, of which, social intelligence is the key to intelligent industry and smart city.

“Big 5G” will integrate the three worlds into one unit, and shape the cyber-physical-social systems (CPSSs) with the parallelism of virtuality and reality based on the “three worlds.” All the countries are focusing on digital twins, software twins, and virtual twins, which are the cores of intelligence infrastructure construction. CPSSs place the “society,” namely, the human behavior and relationship, at the central position. “Man is the measurement of everything,” and also the measurement of intelligence, in this case, the “five-power-in-one” situation has been shaped. The five powers are “power of data,” “power of computing,” “power of algorithm,” “power of network,” and “power of blockchain,” which promote the industrial development and the entrance into “Industry 4.0” and “Industry 5.0,” so as to complete the two major stages of the third industrial revolution (Fig. 3).

Therefore, the importance of blockchain or similar technologies must be emphasized. “Knowledge categories” and “Monadao” method have been shaped by blockchain and the developing decentralized autonomous organization (DAO) technology, combined with the philosophical idea of “monad” originated from Leibniz and reconstructed by the mathematics category theory. This process has made the ancient Chinese philosophical idea “Dao” become a kind of modern intelligence engineering and technical requirements, and allowed the future intelligent technology to move towards “TRUE DAO,” namely:

TRUE = trustable + reliable + usable + (effective + efficient)

DAO = (distributed + decentralized) +
(autonomous + automated) + (organized + ordered)

Only in this way can the machines and humankind do the

right things in the right ways with the new complicated intelligent technologies in the social organization. This trend will certainly impact on the education system at all levels from kindergarten to graduate school. As the current education system in China is not much different from the old-style private school system which prevailed a hundred years ago, it does not conform to the knowledge structure and application method of intelligent industry, so it is hard to fulfill the task for the construction of smart society. Therefore, the education should be parallel and intelligentized at first, and the new-type interdisciplinary talents for intelligent industry should be systematically cultivated as soon as possible by profoundly considering the teaching design of the new humanities & social sciences and new engineering sciences as well as their deep integration [6].

3 Essences and goals of intelligent industry and intelligent economics

The essence of intelligent industry lies in creating new spaces and resources while extending the scope and degree of sharing, improving efficiency, and reducing cost with the CPSS infrastructure platform through parallel interaction between virtuality and reality. Fig. 4 provides the framework of the future intelligent “parallel machine”: the physical, social, and cyber spaces will be opened up, and the “Newton machine” in the physical form and “Merton machine” defined by the software will be combined. The emergence of the phenomena at the edge will be converged with the merging of the cloud platform. Human workers and “knowledgeable robot workers” will be integrated into one body to create the

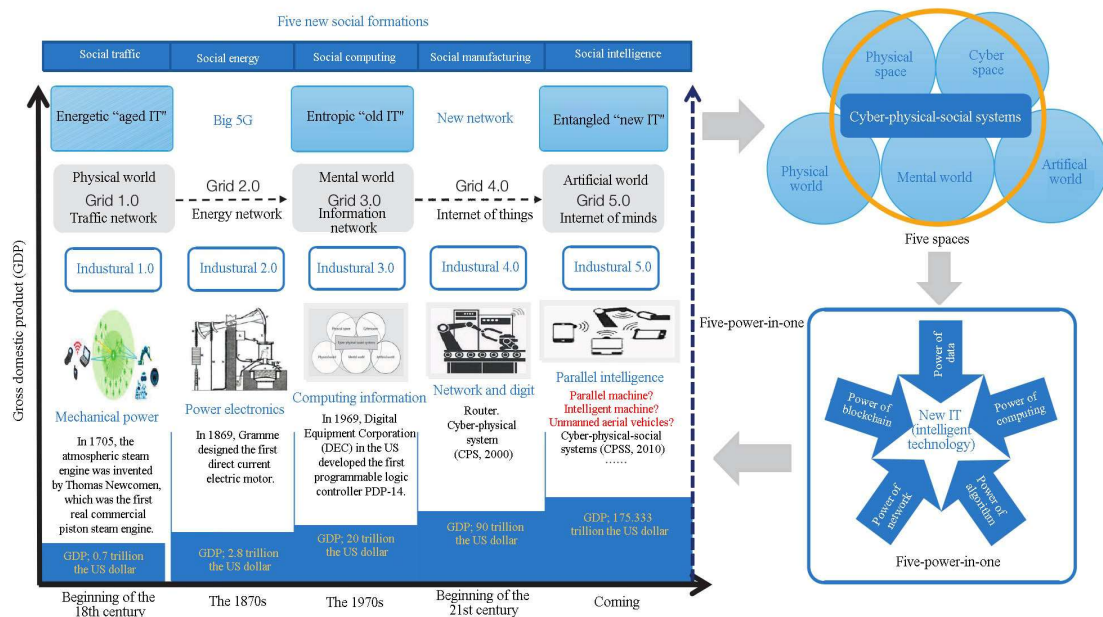


Fig. 3 New engineering sciences, arts, and integrated studies for new infrastructure in the new age

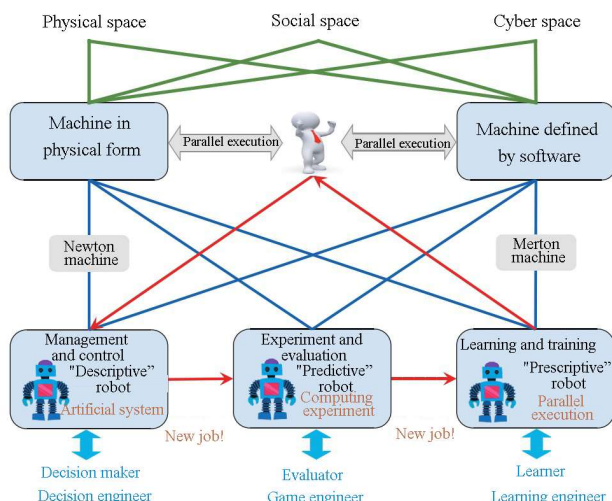


Fig. 4 Parallel workers and machines in parallel enterprises

“all-in-one” new-type “parallel workers” with the “combination of human and machines, merging knowledge and action, and virtuality and reality,” thus achieving the new work pattern and process of “small data–big data–deep intelligence.” The “parallel machine” will not cause unemployment, but instead, it can create a lot of new types of better and healthier jobs for people, and help people transform from “code workers” to “intelligent workers.” With respect to the parallel enterprises, parallel workers, and parallel machines, the core is the knowledge automation, and the “automation of intelligence” of AI will be further formed.

One significant feature of intelligent industry which interacts in parallel between virtuality and reality is that it is safer and more reliable, and can “make a gain in wit after a fall into a pit,” which means “a fall into a pit” in the artificial world will “make a gain in wit” in the real world. One important application of this method is to eliminate “black swan events” to make “long tail effect” normalized and regularized, namely the “ δ - ϵ long-tail normalization” theory. This idea, supported by the parallel test and parallel vision technologies, has achieved a successful practice in the Intelligent Vehicle Future Challenge (IVFC) lasting for 12 years [7,8].

What is the core scientific problem of AI? As shown in Fig. 5, when the complexity of the problem increases, the difference between the cognition of human and the essence of the problem increases gradually, creating “Lighthill cognitive gap” or “modeling gap” of complexity (model and actuality, and cognition and reality, in the simple “Newton systems” are totally different from those in the complicated “Merton systems”). Combination of the big data and parallel intelligence is one of the most promising methods available to overcome the cognitive gap. End-to-end binding between virtuality and reality can be achieved from “gap-filling with data” to “parallel bridging.” Experiments and creations will be conducted in the virtual world at first because the nature of big data is “speaking with data” and “the best way to predict the future is to create the future.” Thereafter, the ACP method for parallel

intelligence will be derived naturally. ACP involves artificial systems based on the digital twins, software twins, and virtual twins, computational experiments based on emulation, simulation, and imitation, and parallel execution based on decision generation, decision recommendation, and decision support. The descriptive, predictive, and orientative knowledge and intelligence are generated, and the parallel control and parallel management systems for dual-feedback and big closed-loop of virtuality and reality are eventually shaped. In this case, the “small data–big data–deep intelligence” circulation process will be intelligent, converting the natural society of uncertainty, diversity and complexity (UDC) into the engineering systems of agility, focus and convergence (AFC). As a result, “all changes shall adapt to being unchanged” in the virtual world with parallelism. The small data will be turned into big data, and the big data will be refined into deep intelligence. Once there is any problem, it can be solved with the “smart contract” of the blockchain in the real world according to the thought that “being unchanged shall adapt to all changes,” and thereby, the realistic task of the UDC will be turned into the working competence of the AFC [9,10]. Mathematically, it is to establish the Newton equation in a real system, and the Merton equation in a virtual system, so as to form parallel dual equations, and make them entangle, parallel, and intersect. A number of remarkable research results have been obtained with this train of thought [11–13].

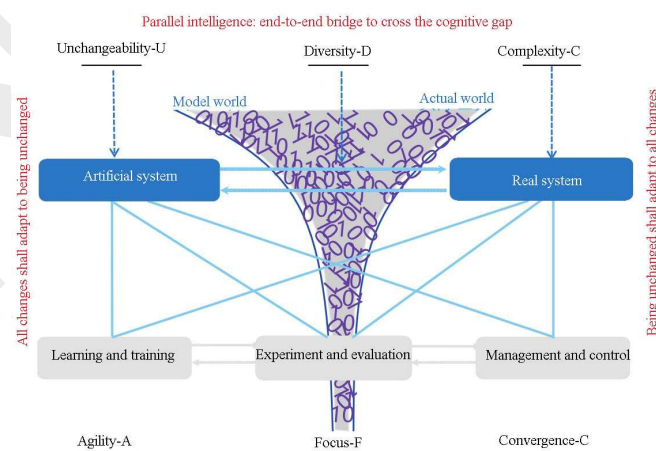


Fig. 5 Parallel intelligence and cognitive gap based on ACP (artificial systems, computational experiments, and parallel execution) and big data

The intelligentization and smartness of management economy guarantee the benefits of intelligent industry. Therefore, management economy is the second field impacted by AI after education. The reason is obvious, because intelligent technology has transformed the basic elements of economic management as well as their association. For example, the robot has changed the productivity, big data changed the means of production, and blockchain changed the relations of production, and so on. Meanwhile, the com-

bination of big data and blockchain has provided solid foundation for the intelligent construction of management economy, and made AI become the driven force to promote the social intelligence rather than just studying the “toy issue.”

More importantly, the essence of intelligent economics and smart society is the revolutionary extension of the commodity space. From the agricultural economy to industrial economy, the main cause is the commercialization of the non-commodity in the original mental world. For example, “fashion” is a new commodity which can be mass-produced by textile machines and textile. Malthus’s poverty trap, which broke the “curse” of diminishing marginal utility in the agricultural society, increased gain yield, and caused population booming, opened up a new space and new frontier for the commodity economy in world 2, and made the specialization of work and mass production become possible. From then on, human entered the industrial society. Herbert Simon ever said that there are two things in the world that cannot be made into commodities, and they are attention and credit. Due to the limited rationality and cognitive ability of human, attention and credit cannot be mass-produced and circulated. Nevertheless, from Google to Tmall, the present intelligent technology, especially the future blockchain intelligence, vividly changes the attention and credit into new economic commodities which can be mass-produced and circulated. This is just like advancing from agriculture to industry, which is the advancement from world 1 to world 2, and now we must continue to advance to world 3 from industry to intelligent industry. In nature, this is just a great development in the artificial world by utilizing the “new IT” (intelligent technology). New commodities and economic space generate in this way, and the artificial world become the new space and new frontier for incremental economic growth of the marginal utility, providing infinite new approaches for humankind to enhance the management efficiency^[14]. Intelligent economics formed from the specialization of work in the classical economics to the division of work between human and machines in the modern economics. Until the division of work between virtuality and reality in the parallel economics, the development of smart society had a specified direction—big economy of intelligence (BEI)^[14].

Since 2004, we have started the study on the parallel economics^[15]. The basic equation which changed the supply–demand philosophy was proposed in terms of the Newton-Merton antithesis^[16], the traditional Say’s law of market and Keynesian law of market was brought into unity, and the parallel supply–demand relation was shaped at last. In this way, the two contrary claims that “supply creates its own demand” in the Say’s law of market and “demand creates its own supply” in the Keynesian law of market were unified with the parallelism. With the market virtuality, software, or digital twins, supply created actual demand mainly in the physical market, and demand created artificial supply mainly in the artificial market, making the supply-side reform and

demand-side reform unified and opposite, and shaping the self-consistent balance indicated by the parallel supply–demand equation. Meanwhile, the parallel supply–demand equation also indicated that the mathematical chaos-type disorder generated the vast majority of the supply–demand systems. Therefore, the long-term stable supply–demand balance cannot be maintained only by technical means.

4 Parallel philosophy: from “being” and “becoming” to “believing”

As being revealed in the discussion of the supply–demand issue in the intelligent economics, we must soberly recognize that it is far from enough to only use intelligent technology in the intelligent age. The new thinking and new philosophy matching with the new age are required, and a new social paradigm must be created. However, what is the new philosophy in the intelligent age? Where are the new points? In the western culture, both philosophy and science are originated from the same person—Thales, “the top of seven sages” in ancient Greece, who has been honored as the first ancestor of philosophy and science. His most famous saying is “everything has been originated from water.” However, Heraclitus, the successor of Thales, believed that “everything has been originated from fire” and stressed “becoming” and “everything is moving.” Heraclitus insisted that “people cannot step twice into the same river,” making “becoming” become the core category of philosophy. Therefore, Heraclitus is regarded as the earliest “process philosopher.” Contrary to “becoming,” the later ancient Greek philosopher Parmenides believed that “being” was eternity, immobility, continuous indivisibility, and the only truth, and only the abstracted idea can be thought over. In his opinion, “being” is “the way of truth,” and “becoming” is “the way of view point.” Therefore, Parmenides believe that there is no thought beyond “being,” and the thing which is thought over and the goal of thought are the same. Parmenides was the first philosopher to raise the thesis of “thought is the same as being,” which is of the same nature as “I think, therefore I am” raised by Descartes in modern times, so Parmenides was recognized as the first ancestor of metaphysics and opener of philosophical thinking on by the later generations. From then on, “being” and “becoming” have become two core philosophical categories that have continued to the present day. The study on “being” and “becoming” is nearly all of the current western philosophy.

The subject of western philosophy has been generated from “being.” Especially, Kant’s “universal phenomenology,” Hegel’s “phenomenology of spirit,” Husserl’s “transcendental phenomenology,” Heidegger’s “phenomenology of being,” and Merleau-Ponty’s “phenomenology of cognition” have created a huge and complicated philosophical system about the descriptive knowledge from the idealism to

materialism. From *the Book of Changes* on changes in the ancient China to “becoming” idea founded by Heraclitus, there nearly has been no independent philosophical system of which the subject is “becoming,” and most of the philosophical systems are connected to or cannot be separated from “being.” However, the process philosophy of Whitehead^[17] is worthy of special attention. The core of the process philosophy is that, it is believed that “actual existence is a process of change,” and “change is the creative progress towards novelty.” Whitehead pushed Aristotle’s “Effective Causality” towards “Singular Causality” from the materialism to organic realism by focusing on “creativity,” and founded “Organic Philosophy” in the process of change, which may become the core of the philosophical system of the predictive knowledge about “becoming”^[17].

To found a new philosophy for intelligent science and technology from thinking, it is the time to introduce “believing” now. “Believing” is directly connected to turning credit and attention into commodities. The gist of “believing” is to make “being” “become” the goal state from the current state, and make people “believe” that this process can become a definite phenomenon (the essence of phenomenology) by engineering and technical means. Moreover, the process of phenomenon change from UDC to AFC mode must be describable, predictable, and guidable. For this reason, the new philosophical system about the prescriptive knowledge for “believing” must be found.

Based on “real object” and “abstraction” or “virtual object” in Whitehead’s process philosophy, the current idea of “digital twins,” and the holism and scientific realism of Quine, the student of Whitehead^[18], we have proposed parallel philosophy^[19]. Parallel philosophy, as a world view surrounding the “three worlds,” constructs parallel scenarios and parallel spaces allowing parallel intersecting, entangling,

and interacting between virtuality and reality, creates the real-time embedded idea and mechanism in the feedback closed-loop of the “real object” and “virtual object,” and turns the grand Utopian social engineering of Hegel into the simple and piecemeal social engineering advocated by Popper^[20].

As shown in Fig. 6, the “three kinds of ideology,” “three kinds of knowledge,” and “three philosophies” correspond to the “three worlds,” and accordingly, there are also “three kinds of intelligence”: ① algorithm intelligence in the physical world; ② language intelligence (LI) in the mental world; ③ imagination intelligence (II) in the artificial world, as well as the corresponding generalized Godel’s intelligence theorem and principle of precision. Algorithm intelligence is far smaller than LI, and LI is far smaller than II. Uncertainty of algorithm intelligence in the physical world, being unable to explain clearly of LI in the mental world, and being unable to think clearly of II in the artificial world are all deeply connected with the “3C” principle (non-communicability, non-comparability, and non-commensurability) advocated by Kuhn in *The Road Since Structure*^[21]. The “3C” principle in some ways is just the philosophical version of Godel’s incompleteness theorem in the mathematics. The roots of “3C” principle are the uncertainty, diversity, and complexity from the linguistic “dictionary network and the multidimensional structure” and imagined “consciousness network and the multidimensional structure.”

Establishment of parallel philosophy must be supported with parallel thinking and parallel cognition, which is the only road from perception to philosophy, and then to science. As has been pointed out by Engels, “the theoretical thinking in every age, including this age, is the product of the history, and it has totally different forms and contents in different ages.”

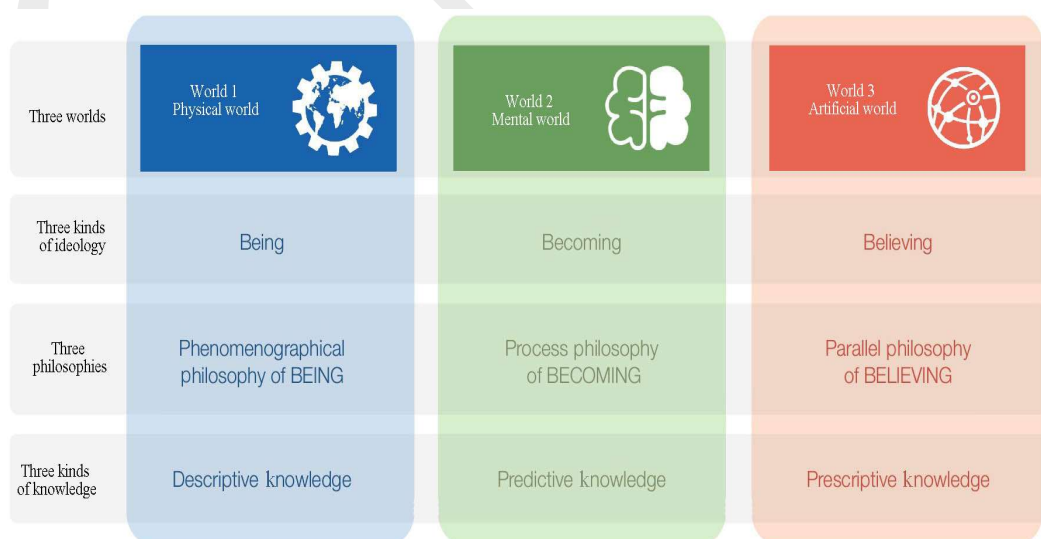


Fig. 6 Parallel philosophy: parallel interaction and entanglement between virtuality and reality and the prescriptive knowledge system

5 Outlook

In the history of philosophy, when thinking over “monad,” Leibniz believed that “Whatever is, is one.” Quine answered Hamlet’s question of “To be or not to be”: “To be is to be a value of a variable.” When studying Leibniz, Russell felt the diversity of monad, and sighed: “And whatever are, are many.” George Boolos, a philosopher and logician, stated in his article: “To be is to be some values of some variable.” Nevertheless, everything is a process between extremities, which is what Whitehead thought: “Whatever goes, goes in process.” For us, the essence of the process is the eternal parallel entangling process between virtuality and reality, so we have “Whatever goes, goes in parallel.” Since then, from Heidegger’s “being-in-the-world,” to “becoming-of-the-world,” and further to “believing-for-the-world, and from the views of “in-the-between” to “among-the parallel,” we have entered the “3B” philosophy of “being, believing, and becoming” and corresponding circular causality—I am, therefore, I believe; I believe, therefore, I think; I think, therefore I am, as shown in Fig. 7.

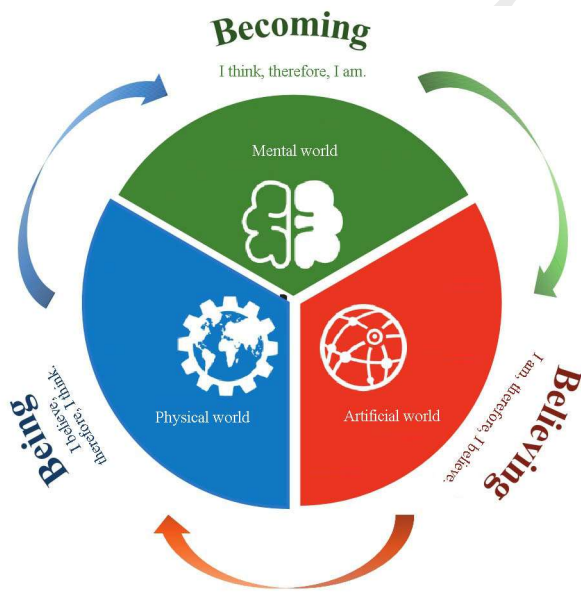


Fig. 7 From circular causality to parallel causality of the “three worlds”

More than seventy years ago, similar causality theories gave rise to Wiener’s cybernetics and the prototype of computational intelligence based on the artificial neural network, and the deep learning and AlphaGo were generated. We believe that the “new IT” will initiate and develop a new era in the artificial world. Parallel philosophy will direct people’s conventional object of thinking towards the ecosystem, and integrate the natural ecology, social ecology, and knowledge ecology in the “three worlds,” so as to advance to the parallel ecology and federated ecology interacting between virtuality

and reality^[22,23]. Parallel philosophy will further push human development to the new circumstances of “6S”: safety in the physical world, security in the network world, global development sustainability, sensitivity to privacy and personalized individual development, full service, and social smartness.

Acknowledgements

Thanks to HAO Liu-Xiang, LIU Chuang, SUI Jian-Guo, XING Tao-Tao, WANG Wei, ZHAI Zhen-Ming, ZHANG Zeng-Yi, SUN Xiao-Chun, ZHANG Ting-Guo, ZHANG Li-Ying, et al., for the help during writing of this paper.

References

- 1 Wang F Y, Zhang J J, Zheng X H, et al. Where does AlphaGo go: From Church-Turing Thesis to AlphaGo Thesis and Beyond. *IEEE/CAA Journal of Automatica Sinica*, 2016, 3 (2): 113–120.
- 2 Popper K. Three Worlds. The Tanner Lecture on Human Values. Ann Arbor: The University of Michigan, 1978.
- 3 Wang F Y. 新 IT 与新轴心时代: 未来的起源和目标. *Exploration and Free Views*, 2017, (10): 23–27 (in Chinese).
- 4 Jaspers K J. The Origin and Goal of History. New Haven: Yale University Press, 1953: 294.
- 5 Wang F Y, Zhang J. Internet of Minds: The Concepts, Issues and Platforms. *Acta Automatica Sinica*. 2017, 43 (12): 2061–2070 (in Chinese).
- 6 Wang F Y. How to Cultivate Artificial Intelligence Talents: From Parallel Teaching to Smart Education. *Science & Technology Review*, 2018, 36 (11): 9–12 (in Chinese).
- 7 Li L, Wang X, Wang K F, et al. Parallel Testing of Vehicle Intelligence via Virtual-Real Interaction. *Science Robotics*, 2019, 4 (28): eaaw4106.
- 8 Li X, Wang F Y. Parallel Visual Perception for Intelligent Driving: Basic Concept, Framework and Application. *Journal of Image and Graphics*, 2021, 26 (1): 67–81 (in Chinese).
- 9 Wang F Y. Parallel System Methods for Management and Control of Complex Systems. *Control and Decision*, 2004, 19 (5): 485–489 (in Chinese).
- 10 Wang F Y. CC 5.0: Intelligent Command and Control Systems in the Parallel Age. *Journal of Command and Control*, 2015, 1 (1): 107–120 (in Chinese).
- 11 Wang F Y. Parallel Control and Digital Twins: Control Theory Revisited and Reshaped. *Chinese Journal of Intelligent Science and Technology*, 2020, 2 (3): 293–300 (in Chinese).
- 12 Wei Q L, Li H Y, Wang F Y. Parallel Control for Continuous-Time Linear Systems: A case study. *IEEE/CAA Journal of Automatica Sinica*, 2020, 7 (4): 919–928.
- 13 Lu J W, Wei Q L, Wang F Y. Parallel Control for Optimal Tracking via Adaptive Dynamic Programming. *IEEE/CAA Journal of Automatica Sinica*, 2020, 7 (6): 1662–1674.
- 14 Wang F Y. 智能经济的“真”与“道”: 新商品、新空间、新边际. *New Economy Leader*, 2019, (2): 4–7 (in Chinese).
- 15 Wang F Y. Artificial Societies, Computational Experiments, and Parallel Systems: A Discussion on Computational Theory of Complex Social-Economic Systems. *Complex Systems and Complexity Science*, 2004, 1 (4): 25–35 (in Chinese).
- 16 Wang F Y. Parallel Economics: A New Supply-Demand Philosophy via Parallel Organizations and Parallel Management. *IEEE Transactions on Computational Social Systems*, 2020, 7 (4): 840–848.
- 17 Whitehead A N. *Process and Reality*. New York: Free Press, 1979: 448.
- 18 Quine W V O. *Word and Object*. Cambridge: MIT Press, 2013: 277.
- 19 Wang F Y. Parallel Philosophy and Intelligent Science: From Leibniz’s Monad to Blockchain’s DAO. *Pattern Recognition and Artificial Intelligence*, 2020, 33 (12): 1055–1065 (in Chinese).
- 20 Karl P. *The Open Society and Its Enemies*. London, New York: Routledge, 1945.
- 21 Kuhn. 可公度性、可比较性、可交流性. Translated by Wang F Y. *International Philosophy Today*, 2004, (3): 3–16 (in Chinese).
- 22 Wang F Y, Wang Y F. Parallel Ecology for Intelligent and Smart Cyber-physical-Social Systems. *IEEE Transactions on Computational Social Systems*, 2020, 7 (6): 1319–1324.



WANG Fei-Yue, State specially appointed expert and Director of the State Key Laboratory for Management and Control of Complex Systems, Institute of Automation, Chinese Academy of Sciences; Director of China Economic and Social Security Research Center, University of Chinese Academy of Sciences; and President of Qingdao Academy of Intelligent Industries. His research interest covers methods and applications for parallel systems, social computing, parallel intelligence, and knowledge automation. E-mail: feiyue.wang@ia.ac.cn

CNKI